PTO 2009-4069

Japanese Kokai Patent Publication No. S61-095536, published May 14, 1986;

Application No. S59-217187, filed October 16, 1984; Inventors: Minehide TOTOKAWA; Assignee: Sanken Electric Co.

MANUFACTURE METHOD OF RESIN-SEALED TYPE SEMICONDUCTOR DEVICE

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1. Title of Invention:

Manufacture Method of Resin-Sealed Type Semiconductor Device

2. Claims

(1) In a manufacture method of resin-sealed type semiconductor device that is equipped with

A support plate that possesses a heat dissipation function and an electroconductive function,

A semiconductor chip that is firmly fixed on the primary surface on one side of said support plate,

An external lead for support plate connection that is coupled to one end of said support plate,

At least 1 external lead for connection with the chip that is connected to said semiconductor chip either via or not via an internal lead,

And a molded resin body that coats part of the side of the support plate with external leads that are used for connection to said support plate and for connection to said chip, said semiconductor chip, and said support plate, and thinly coats not only one primary surface side of said support plate but also all or almost all of the other primary surface side, -

Manufacture method of resin-sealed semiconductor device characterized in that it includes the process of preparing a lead frame wherein in order to obtain a plurality of said semiconductor devices, a plurality of said support plates, said external leads for the connection of support plates, and said external leads for the connection of chips are arranged in parallel, and said plurality of leads for the connection of the support plates and for the connection of chips are coupled mutually by means of a lead coupling part and at the same time said plurality of support plates are also coupled mutually by means of a support plate coupling part; said lead coupling part is provided in a section that is not covered by said molded resin body, and when said support plate coupling part is cut away in a process described later, the cut-off surface is provided in a section that is not directly exposed from the side surface of said molded resin body;

Then, a process in which said semiconductor chips are individually firmly fixed to said plurality of support plates of said lead frame, and said external leads for the connection of said chips are connected to said semiconductor chips via or not via internal leads;

Then, a process of cutting away said support plate connecting part;

Then a process wherein said molded resin body is provided by injecting liquid resin into molding die, resulting in the cutaway surface of the section where said support plate connecting part was cut away from said support plates not being exposed on the side surface of said molded resin body.

(2) The manufacture method of semiconductor device of Claim 1 wherein the process whereby said molded resin body is provided is one in which liquid resin is injected while the molding die is in contact with at least part of said primary surface side on one side of said support plate.

3. Detailed Explanation of Invention

[Field of Application in Industry]

This invention concerns a manufacture method of resin-sealed semiconductor devices, such as power transistors, power diodes, etc.

[Prior Art]

In a common resin-sealed semiconductor device of Prior Art, e.g., power transistor, a resin layer is not formed on the surface of the support plate to which is firmly fixed the semiconductor chip. Therefore when this power transistor is attached to an external heat dissipator, a thin plate of insulating material with good insulating characteristics such as mica etc. must be inserted must be inserted for electric insulation between them, which made cumbersome the process of attaching power transistors.

In order to eliminate this drawback, for example, as disclosed in the Japanese Patent S57-147260, a design was suggested in which a thin molded resin body (a few hundred µm thick) be formed also on the surface of the heat dissipating support plate, and the thin plate of mica was no longer needed.

However, in the above-mentioned patent, in order to securely place the support plate in the space used for molding, resin sealing is carried out with external leads that extend from the support plate and thin strips that extend from the support plate held between the matching parts of the forming mold, and the thin strips that extend form the side surface of the molded resin body are cut off after resin sealing. That is, in a finished power transistor, the cut-off parts of thin strips protrude from the side surface of the molded resin body, which is a drawback since they could easily cause short-circuiting malfunctions in their surroundings and defects of insulators between heat dissipators.

[Problems to be Solved by Invention]

The above-mentioned shortcomings by means of cutting off the thin strips that support the support plate. However, since this results in a design where the support plate is supported on one side, it is difficult to form thin molded resin body that is a few hundred µm thick on the surface of the support plate. Such a problem is caused not only by the shifting position of the support plate when the resin is injected in the forming space of the mold, but it is also due to the deformation of the lead frame in the course of lead frame storage, chip mounting and lead connection operations or in the course of placement in the die etc. Moreover, if a lead frame is used in which the support plate is supported on one side only by external leads, then the support plate will shift not only upwards and downwards (in directions that are perpendicular to the primary surface) but also to the right and left (in directions that are parallel to the support plate). This result makes handling the lead frame difficult and hinders the chip bonding operation, the internal lead bonding operation, etc. Problems, such as described above occur in the method where part of the support plate is supported by the die during resin injection. That is, if part of the support plate is supported by the die, this achieves the goal of determining the position of the support plate with regard to the inside of the molding space, but since prior to placing the lead frame in the die the support plate shifts freely, this hinders the handling of the lead frame, and adversely affects its workability. Therefore, the goal of this invention is to offer a method of easily manufacturing resin-sealed semiconductor devices that have a resin coating layer on the surface of the chip support plate.

(Means of Solving Problems)

This invention that achieves the above-mentioned goal includes the process of preparing a lead frame that has a plurality of support plates mutually coupled. It also includes a process of bonding the chip to this lead frame and, after carrying out the lead connection, cutting away the lead plate coupling part.

(Operation)

Based on this invention, when placed in the die, the support plate of the lead frame is separated, but since until that moment it was mutually coupled to the support plate coupling part, it is possible to suppress the shift and deformation of the support plate and the chip bonding operation, the lead connection operation, etc. can be carried out accurately and quickly. Moreover, even though there is a support plate coupling, since it is cut off before a molded resin body is provided it is not directly exposed on the side surface of the molded resin body. Therefore by providing a support plate coupling part insulating properties are not reduced.

[Embodiments]

We will describe the manufacturing method of resin-sealed power transistor pertaining to an embodiment of this invention referring to Figs. 1 ~ 9. First, lead frame 1 show in Fig. 1 is prepared. Fig. 1 shows only 2 transistors, but actually there may be several (for example, 10) of them arranged in parallel. 2 is a support plate that has both a heat dissipating function and an electroconductive function. 4 is an external lead for the connection of support plate that was coupled to one end of the support plate 2. 3 and 4 are leads for the connection of chip via internal leads, and they function as a base lead and emitter lead. Individual external leads 3, 4, and 5 are formed from the same material as the support plate and can change their form relatively easily. 6 is a tie bar that bridges external leads; 7 is a strip that couples lead ends to each other.8 is a guide hole that firmly fix the lead frame and prevent it from shifting. The support plate 2 has a thick part 2a to which the chip is bonded, and in addition, one end side where the external leads 4 are led out, and a thin part 2b that is folded upward on the other end side across from the first one. In the support plate 2, a U-shaped notches 9 are provided, therefore the other end of the support plate 2 is bifurcated, and the thin part 2b is provided on each branch. This thin part 2b has a part that stands up straight from the thick part 2a and a part that extend parallel to the thick part 2a, such that its cross-section is L-shaped.

10 is the support plate coupling part in accordance with this invention; it is a part where the gaps between adjacent support plates 2 are coupled by means of the thick part 2b. This support plate coupling part 10 is ultimately an unneeded part that gets cut off in a subsequent process. However, support plate coupling part 10 is cut off prior to the placement of the lead frame 1 in the die, unlike the tie bar 6 and the coupling strip 7.

Next, as shown in Fig. 2, the silicon power transistor tab 11 is firmly fixed o the primary surface on one end of the support plate 2 by means of solder (not shown in the Figure). Chip 17 has a base electrode and emitter at the top and at the bottom, a collector electrode; therefore the collector electrode, therefore the collector electrode is connected to the support plate. Next the gap between the base electrode of the chip 11 and the external lead 3, as well as the gap between the emitter electrode and the external lead 5 are connected by means of internal leads 12 and 13 that are made of Al wire using an ultrasound wire bonder. In these processes and during the accompanying storage and transportation of the lead frame, a plurality of support plates 2 are mutually coupled by means of support plate coupling part 10. Therefore disadvantages, such as the support plates 2 shifting up, down, left or right and adversely affecting workability or reducing production yield, do not arise.

Next, as shown in Fig. 3, the support plate coupling part 22 of the lead frame 1 cut off and removed by press treatment, separating individually a plurality of support plates 2.

Then as shown in Figs 4 and 5, this lead frame 1 is mounted on the die for resin sealing. 15 is the top die, 16 is the bottom die, 17 is the side die, and the lead frame 1 is accommodated in the molding space 18 formed by mold-clamping these. Moreover, the end part of the thin part 2b of the support plate is held between the protrusion 15a that projects in the manner of a screen from the top surface and the side surface of the internal wall of the upper die (15) and the protrusion 17a that projects from side surface of the internal wall of the inner die 17. Since the thin part 2b is bifurcated, the protrusions 15a and 17a are formed in 2 places such that they must match the two sides of the bifurcation. By holding between these, yet another end part if the support plate 2 is firmly fixed, and the thick part of the support plate 2a is firmly fixed suspended at a distance of 0.4 mm from the bottom die 16; the support plate 2 does not have shifts or fluctuating movement during subsequent resin injection.

The cylindrical pin 15b of the top die 15 serves to yield mounting holes in completed elements and goes through the notch 9 of the support plate 2. The dividing protruding part 15c that is provided in the top die 15 is a part that limits the flow of resin at the top in order to prevent incomplete resin filling on the inside of the thick part 2a of the support plate 2 when resin is injected. 15 is the gate (molding resin injection port).

Next, based on the universally known transfer molding method, thermocurable epoxy resin in the shape of heated viscous fluid fills under pressure the inside of space 18 through the gate 19. Individual dies 15, 16, and 17 are heated to the temperature at which the resin is cured (150 ~ 200 ℃). The resin that was filled under pressure is cured within a short time (within a few minutes), and as shown in Figs 6 and 7, a molded resin body 20 is formed. The cut-off surface of the support plate coupling part 10 is completely covered with the molding body 20.

Next, the die's clamping is undone, and the lead frame 1 is removed from the die, and, in order for the molded resin body 20 to completely cure under heat, it undergoes additional thermal treatment for a long time, and finally the tie bar 6 and the common connection strip 7 are cut off and removed by press treatment. The power transistor shown in Fig. 8 is completed. 21 and 22 are recessed parts formed to match the protrusion 15a that was formed in 2 places of the top die. 23 and 24 are recessed parts formed to match the protrusion 17a that was formed in 2 places of the side die. 25 is formed to match the cylindrical pin 15b of the top die; this is a mounting hole that serves to insert the screw etc. when this transistor is attached to an external heat dissipater. 26 is a groove-shaped recessed part that is formed to match the protrusion part 15c of the top die.\In this power transistor the support plate 2 is exposed on the outside in the recessed parts 21, 22 and 23, 24. However, there is a sufficiently large distance between these exposed parts and the external heat dissipater (not shown in the Figure) that is provided adhering to the bottom surface of the molded resin body 20 along creepage surface (distance along the surface of the molded resin body 20). That is, in this embodiment, the protrusion 17a that is provided in the side die is separated from the bottom surface of the internal wall of the bottom die 16; therefore the recessed parts 23 and 24 are formed such that the side surface of the molded resin body 20 has openings, and the thin part of the 2b of the support plate that is exposed on the top inner wall of the recessed parts 23 and 24 does not directly face the external heat dissipater. Due to this, the creepage distance from the exposed part to the external dissipater becomes longer and occasions of poor insulation are vastly improved. Moreover, the creepage distance between the head of the screw (electrically connected to the external heat dissipater) that goes through the mounting hole 25 and the exposed part of the support plate 2 also becomes a problem, but, due to the presence of a certain depth of the recessed parts 23 and 24 and to the positions of the recessed parts 21 and 22 being separated from the mounting hole 25 in fact, the creepage distance is assured without any problems. With regard to short-circuiting malfunctions, said exposed parts are in places where it is hard for contact to occur; therefore in fact there is no concern. Therefore, these power transistors in fact completely solve the problems of Prior Art, i.e., short-circuiting malfunctions and poor insulation. Moreover, since the support plate coupling part 10 is cut off prior to resin molding, the cut-off surface is covered by the molded resin body 20 and insulation here is not adversely affected.

This invention is not limited to this embodiment; for example, the following modifications are possible.

(a) If a product is desirable where the support plate 2 is not exposed completely, resin can be injected also in the recessed parts 21 ~ 24. Furthermore, it is also possible to obtain a semiconductor device in which the support plate 2 is completely coated with an insulator, by first forming an insulating layer such as a polyimide resin layer in the parts that are in contact with the protrusions 15a and 17a of the die of support plate 2 and holding the support plate 2 between the protrusions 15a and 17a above this insulating layer.

(b) If the flow of the resin that is injected in to the molding space 18 is controlled by the protrusion part 15c provided in the top die, then the resin flow to the rear surface side of the support plate 2 is improved and the injected liquid resin acts to push the support plate 2 upwards. Therefore there is no need for protrusion 17 a in the side die 17. In this case, top die protrusion 15a acts as a stopper on the top side of the support plate 2. In this case, the proximity of the interface between the support plate 2 and the external lead 4 is prepared in advance to be slightly curved upwards; it is configured inside the space 18 and, using the spring pin of the lead frame, the support plate 2 may be pushed onto the protrusion 15a. Furthermore, instead of protrusions 15a, 17a, cylindrical pins of the dies 15 and 16 can be provided, and the support plate 2 can be held between pins at least from the left end of the space 17 in Fig. 4 to the position on the right. Moreover the protrusions 15a and 17a, without being placed opposite each other, can be brought into contact with the support plate 2 in displaced positions when on a planar view.

(c) The recessed parts 21 and 22 reach the top surface of the molded resin body 20, but they can be formed to have an opening only on the side surface of the resin body 20, similar to the recessed parts 23 and 24. In such a design protrusion 15a is formed similar to the protrusion 17a, and this is easily achieved by making this part into a side die. In this manner, the creepage distance is increased.

(d) Instead of the U-shaped notch (9), a through hole can be provided and the thin part 2b is then continuously extended. Moreover, the position in which the coupling part 10 is provided can be slightly displaced to the external leads 3 ~ 5. Furthermore, in the embodiment the cut-off surface after the removal of the coupling part 10 is fully covered by the molded resin body 20, but it is also possible to form the die such as to make a hole in the side surface of the molded resin body 20, such that the cut-off surface is exposed inside this hole. If the hole in the side surface is deep, the creepage distance is increased, and insulation is unlikely to deteriorate. Moreover support plates 2 can be coupled by a plurality of coupling parts.

(Effect of Invention)

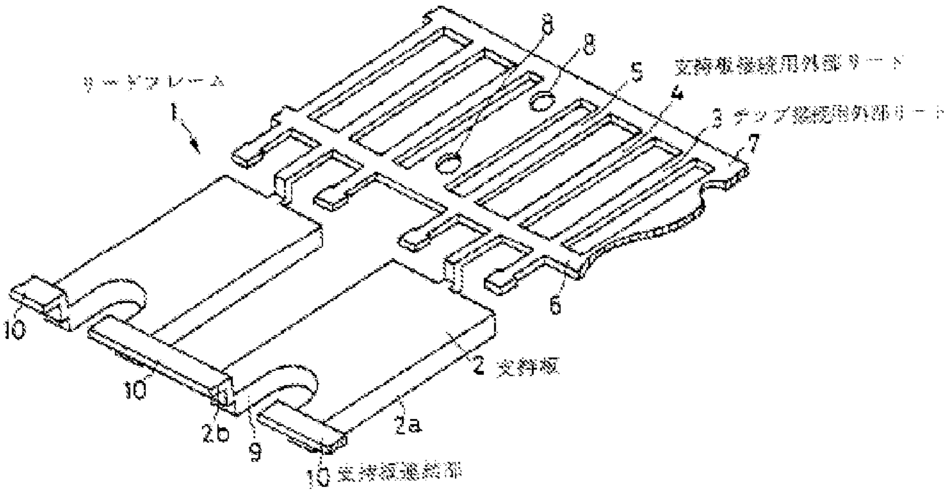
As is clear from what was described above, during the chip bonding and the lead connection the support plates are mutually connected, therefore the displacement of the support plate position is small, and the operation is easy. Even though a support plate coupling part is provided, it is cut off prior to placement in the die and, since it is not directly exposed on the side surface of the molded resin body 20, poor insulation is prevented from occurring here,

4. Brief Explanation of Figures

Fig. 1 shows an oblique view of the power transistor pertaining to this invention. Fig. 2 is an oblique view that shows how the chip is bonded to the lead frame and how the inner leads are connected. Fig. 3 is an oblique view that shows how the support plate connecting part is cut off and removed from the lead frame. Fig. 4 is a cross-section drawing that shows how the lead frame of Fig. 3 is accommodated in the die on the cross-section along the external leads 4. Fig. 5 is a cross-section that shows the die and lead frame on a cross-section along the external leads 5. Fig. 6 and Fig. 7 are cross-sections that show how the resin body is provided in the space of Figs. 4 and 5. Fig. 8 shows an obliques view of the finished transistor. Fig. 9 is a planar view that shows part of the transistor of Fig. 8.

1 – lead frame; 2 – support plate; 3 – external leads for chip connection; 4 - external leads for support plate connection; 5 - external leads for chip connection; 10 – support plate coupling part; 11 – chip; 12, 13 – internal leads; 18 – molding space; 20 – molded resin body.

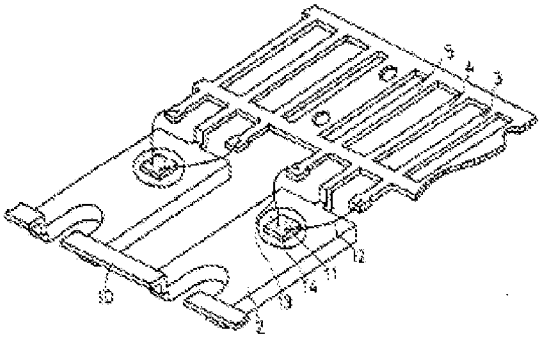
第 1 図



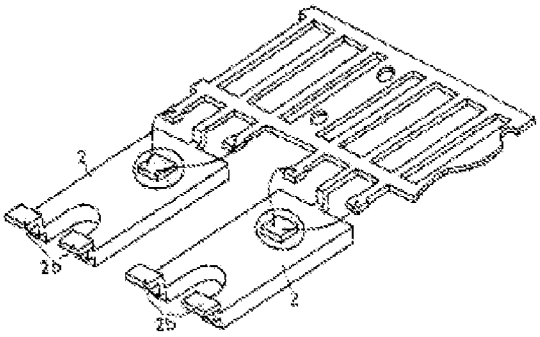
Key to Fig. 1

1 – lead frame; 2 – support plate; 3 – external leads for chip connection; 4 – external leads for support plate connection; 10 – support plate coupling part.

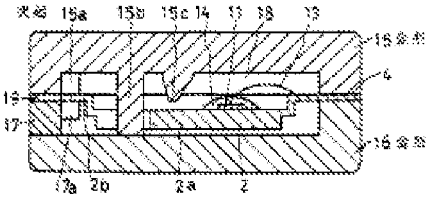
第２図



第３図



第 4 図



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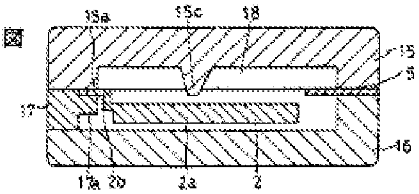
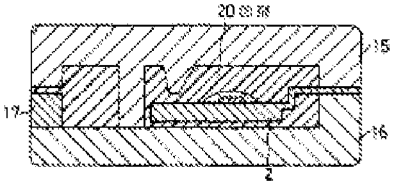
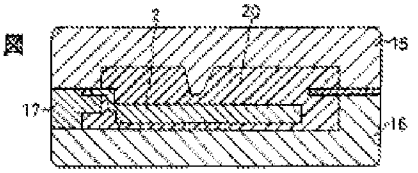


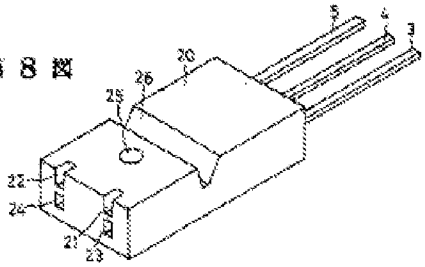
第 6 図



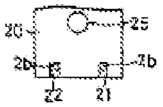
第 7 図



第 8 図



第 9 図



Key to Fig. 4

15 – die; 16 - die

United States Patent and Trademark Office
Translations branch
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March 27, 2009